Yellowstone's hot pools contain organisms that thrive in extreme heat and pH. Ongoing research into these organisms has yielded a catalase revolutionary to hydrogen peroxide-using industries.

Ultrastable Catalase Enzyme from Yellowstone Bacteria

In one of Yellowstone National Park's hot springs lives a type of bacterium called *Thermus brockianus*, which produces an enzyme that can make industrial bleaching cheaper and more environmentally friendly. INL scientists have found that the new Ultrastable Catalase Enzyme lasts orders of magnitude longer in harsh industrial conditions than currently available catalases, making it a cheaper alternative for treating hydrogen peroxide wastewater. *R&D Magazine* included this discovery as one of the 100 most significant technological advances for the year 2004.

The challenge of harsh environments

Cloth and paper manufacturers and other industries are relying increasingly on hydrogen peroxide instead of chlorine to whiten and disinfect products. Using a catalase to break down leftover hydrogen peroxide is the most direct way for industries to treat wastewater. But most types of commercial catalases come from organisms that live at about room temperature and the alkalinity and high temperatures of industrial processes quickly destroy the enzyme.

INL's hardy solution

To find a better alternative, INL researchers turned to

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a microbe they found in Yellowstone National Park. *T. brockianus* thrives in the steamy waters of hot springs — conditions similar to those in industrial applications. After isolation from the microbe, the catalase's industrial half-life was found to be 15 days instead of the 15 seconds of other catalases — an 86,000-fold improvement. This makes the Ultrastable Catalase Enzyme both powerful and inexpensive to use.

Decades of high cost and environmental impact

By the 1980s, industrial chemists had started to replace chlorine bleaching with greener hydrogen peroxide, which can be broken down into water and oxygen after the bleaching step.

Industries that switched to hydrogen peroxide developed wastewater treatment options, such as diluting wastewater with pure water. This is expensive and produces even more waste. Another solution has been to treat peroxide chemically with salts, but the remaining harmful waste essentially cancels the environmental benefit of using hydrogen peroxide.

The most direct wastewater treatment so far uses a catalase to break down hydrogen peroxide. But industries working with commercial catalases have had to make a choice: either spend time and money bringing the wastewater temperature and alkalinity down to tolerable levels, or spend even more money continually adding catalase to untreated wastewater to replenish the enzyme.

The Ultrastable Catalase Enzyme surmounts these extra costs and environmental problems. With this new enzyme, hydrogen peroxide breaks down safely, and wastewater needs no extra pretreatment. What's more, because the catalase has a long industrial life, it can be reused to treat multiple batches of wastewater.

Bringing the technology to real use

Ultrastable Catalase Enzyme can help industries that need to safely whiten and disinfect products such as textiles, paper pulp, food and food containers. The INL team is discussing possible collaborations with enzyme manufacturers to develop large-scale methods of catalase production.

For more information

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INL team members gather samples of organisms in Yellowstone National Park. The catalase-containing bacteria was ultimately found in the pool shown at upper left.